



### ⚙️ Liquid-Metal-Fed Pulsed Plasma Thrusters

A short document proposes liquid-metal-fed pulsed plasma thrusters for small spacecraft. The propellant liquid for such a thruster would be a low-melting-temperature metal that would be stored molten in an unpressurized, heated reservoir and would be pumped to the thruster by a magnetohydrodynamic coupler. The liquid would enter the thruster via a metal tube inside an electrically insulating ceramic tube. A capacitor would be connected between the outlet of the metal tube and the outer electrode of the thruster. The pumping would cause a drop of liquid to form at the outlet, eventually growing large enough to make contact with the outer electrode. Contact would close the circuit through the capacitor, causing the capacitor to discharge through the drop. The capacitor would have been charged with enough energy that the discharge would vaporize, ionize, and electromagnetically accelerate the contents of the metal drop. The resulting plasma would be ejected at a speed of about 50 km/s. The vaporization of the drop would reopen the circuit through the capacitor, enabling recharging of the capacitor. As pumping continued, a new drop would grow and the process would repeat.

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### 🏠 Personal Radiation Protection System

A report describes the personal radiation protection system (PRPS), which has been invented for use on the International Space Station and other spacecraft. The PRPS comprises walls that can be erected inside spacecraft, where and when needed, to reduce the amount of radiation to which personnel are exposed. The basic structural modules of the PRPS are pairs of 1-in. (2.54-cm)-thick plates of high-density polyethylene equipped with fasteners. The plates of each module are assembled with a lap joint. The modules are denoted bricks because they are designed to be stacked with overlaps, in a manner reminiscent of bricks, to build 2-in. (5.08-cm)-thick walls of various lengths and widths. The bricks are of two varieties: one for flat wall areas and one for corners. The corner bricks are specialized adaptations of the flat-area bricks that make it possible to join walls perpendicular to each other. Bricks are attached to spacecraft structures and to each other by use of straps that can be tightened to increase the strengths and stiffnesses of joints.

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### ⚙️ Attitude Control for a Solar-Sail Spacecraft

A report discusses the attitude-control system of a proposed spacecraft that would derive at least part of its propulsion from a solar sail. The spacecraft would include a bus module containing three or more reaction wheels, a boom attached at one end to the bus module and attached at its other end to a two-degree-of-freedom (DOF) gimbal at the nominal center of mass of a sail module. Each DOF of the gimbal could be independently locked against rotation or allowed to rotate freely. By using the reaction wheels to rotate the bus when at least one gimbal DOF was in the free state, the center of mass (CM) of the spacecraft could be shifted relative to the center of pressure (CP) on the solar sail. The resulting offset between the CM and CP would result in a solar torque, which could be used to change the attitude of the spacecraft. The report discusses numerous aspects of the dynamics and kinematics of the spacecraft, along with the relationships between these aspects and the designs of such attitude-control-system components as sensors, motors, brakes, clutches, and gimbals.

*This work was done by Edward Mettler and Scott Ploen of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).  
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